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NOTE

These pages contain the first of the lectures by members of the Princeton faculty, which are to be distributed to the University Alumni.

This lecture, "Has Human Evolution Come To An End?" embodies results of recent scientific researches and reflections upon a topic of universal interest.

The lecture comes from the Biological Department of Princeton at the head of which is Prof. E. G. Conklin, of whom a biographical note follows:

CONKLIN, EDWIN GRANT, Professor of Biology, Princeton University, was born in Ohio in 1863. He has the degrees of B.S., A.B. and A.M. from the Ohio-Wesleyan University, Ph.D from Johns Hopkins, honorary Sc.D. from the University of Pennsylvania. From 1891-94 he was professor of biology at Ohio-Wesleyan University; 1894-96 professor of zoology at Northwestern University; 1896-1908 professor of zoology at University of Pennsylvania, since which time he has occupied the Chair of Biology at Princeton University. He is a trustee of the Marine Biological Laboratory at Woods Hole, Mass. A member of the Advisory Board of the Wistar Institute at Philadelphia. Associate Editor of the Journal of Morphology, the Biological Bulletin and the Journal of Experimental Zoology. He is a member of the National Academy of Sciences; American Society of Zoologists (President 1899); American Society of Naturalists (President 1912); Fellow of the American Association for the Advancement of Science (Vice-President 1907); American Philosophical Society (Secretary 1901-08); Academy of Natural Sciences of Philadelphia (Vice-President since 1901). Honorary member of K. K. Acad. Wissenschaften Prog.; Societe Royale Zoologique de Belgique; Societe Royale de Sciences; Medicales et Naturelles de Bruxelles. The author of about 100 contributions to our knowledge in Heredity, Development and Evolution.

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Has Human Evolution Come to An End?

A LECTURE

By EDWIN GRANT CONKLIN

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The doctrine of special creation taught that man was perfect when he issued from the hands of the Creator, but that his disobedience brought upon him imperfection, degeneracy and death.

The doctrine of evolution teaches that man has come up from animal ancestors, that he is the culmination of this stupendous work of time, and that he is becoming more and more perfect. Indeed many evolutionists assume that there are no limits to the possible evolution of man, that we began in primordial protoplasm and will go on to

"Some far off divine event,
To which the whole Creation moves."

The recent cataclysm which has overwhelmed the world, the present perils of civilization, the threatenings of revolution, the widespread recrudescence of emotionalism and irrationalism have awakened us from this roseate dream.

Let us consider the present position and the future prospects of the human race from the rational rather than the emotional, from the scientific rather than the poetic points of view.

The Principles of Evolution

There is no longer any doubt among scientists that man is descended from the animals, that he is a vertebrate, a mammal, a primate.

Even non-scientific persons generally recognize this animal relationship although John Fiske used to tell of a man who became very indignant when he was told that he was a mammal and replied "I am not a mammal nor the son of a mammal." He added that he had probably been brought up on a bottle.

There is no longer any doubt among leading anthropologists and biologists that not only the body but also the mind and society of man are the products of evolution, and there is no reason to doubt that the great principles of evolution which have operated in the past will continue to act in the future.

* * *

What are these principles?

1. Evolution is transformation and not new-formation; it consists of new combinations of the elements of which organisms are composed, whether those elements be organs or characters, hereditary units or the molecules of which such units are composed and it does not consist in the creation *de novo* of molecules, units, characters, organs or functions.

2. Evolution can take place only by means of changes in the germplasm—the material basis of heredity. The only living bond between successive generations is found in the germ cells which extend back from us without a break to our earliest progenitors.

* * *

The body is mortal, it develops and dies in each generation, but the germ cells are at least potentially immortal.

Changes in heredity are due to changes in the immortal germplasm rather than in

mortal bodies and evolution consists primarily in the evolution of germplasm rather than of developed organisms.

In spite of much controversy, due largely to lack of clear thinking, it is now practically certain that "acquired characters" of the mortal body are not inherited, that is are not transmitted to the germplasm and evolutionary changes are not first wrought in developed bodies but in germplasm. The "New Hope of Hereditary and Evolution" based upon the supposed inheritance of acquired characters has led only to new disappointments.

The Results of Evolution

3. The results of evolution may be summarized in three words—Diversity, Adaptation, Progress.

Diversity is seen in the innumerable variations, mutations and species of the living world. Most of these are no more complex or perfect than the stocks from which they sprung and some of them are degenerate descendants of more perfect ancestors. Diversity in short is mere change, whether progressive or retrogressive, whether useful, indifferent or harmful.

Adaptive evolution is increasing perfection of adjustment to conditions of life. The only scientific explanation of such adjustment or fitness is Darwin's principle of natural selection of the fit and elimination of the unfit and it is eloquent testimony to the greatness of Darwin that more and more this great principle is being recognized as the only mechanistic explanation of adaptation.

Progressive evolution is the advance in organization from the simplest to the most complex organisms, from amoeba to man. Biological progress means increasing complexity of structures and functions, in-

creasing specialization and co-operation of the parts and activities of organisms, and human progress, whether physical, intellectual or social, means no more and no less than this.

The Limits of Progressive Evolution

4. The limits of progress are fixed by its very nature. No single animal or plant, however complex it may be, can combine within itself all the complexities of all organisms. Specialization or differentiation means limitations in certain directions in order to advance in others.

If a creature have wings it cannot also have hands (except in art where angels are given an extra pair of appendages and hair and feathers are mixed regardless of zoological classification); if its limbs are differentiated for running they cannot also be specialized for swimming; if it have enormous strength it cannot also have great delicacy of movement.

Thus while certain animals are specialized in one direction and others in another no one animal can be differentiated in all directions.

Furthermore increasing specialization leads to lack of adaptability; peculiar fitness for any special condition of life means unfitness for other and different conditions.

When differentiations in any one direction go so far that they unfit the organism for any condition of life except a single and special one the chances for survival are greatly reduced and sooner or later this highly differentiated organism becomes extinct or returns to a more generalized type.

* * *

Paleontology is in the main the science of organisms that were too highly differentiated to adjust themselves to the new conditions that came upon them and which therefore became extinct. The death of

species like the death of individuals is the price that is paid for differentiation.

One-celled organisms and all germ cells are potentially immortal, but the highly differentiated bodies of animals and plants and their highly differentiated muscle, nerve and tissue cells are mortal, probably because they are too highly specialized to adjust themselves to all the changing conditions of existence.

Similarly species that are not highly specialized are highly adaptable, and have great powers of survival while those that are highly specialized have little adaptability and consequently are more likely to become extinct.

For this reason new paths of evolution usually start from generalized rather than from highly specialized types.

* * *

The Paths of Progress

5. Millions of diversities exist among organisms and they are appearing continually; thousands of adaptations have arisen during the course of evolution and are still arising; but different lines of progress have been relatively few. The most important paths of progress throughout all past ages have been in the direction of:

- (a) *bodily complexity* or the multiplication and differentiation of cells, tissues, organs and systems;
- (b) *society* or the differentiations and integrations of individuals or persons whether among ants, bees or men;
- (c) *intelligence* or the capacity of profiting by experience which comes with increasing organization of the nervous system.

* * *

a. In all these paths of evolution progress is most rapid at first and it then slows down until it stops.

One-celled organisms reached their utmost limits of complexity millions of

years ago; since then they have shown many diversities, many adaptations, but little if any progress.

Many-celled animals and plants long ago reached the limits of their possible progress in almost every line.

Many new species have evolved and are still appearing, there has been diversification and adaptation almost without limit, but progress in the sense of increasing complexity of organization has practically come to an end.

b. Animal societies represent the highest grade of organization which has yet appeared on earth.

Here the differentiations and integrations of individuals make possible this higher degree of organization. The evolution of animal societies may be traced from a condition in which every member is much like every other and the bond of connection between individuals is a very loose one up to societies of ants, bees and termites in which the specialization and co-operation of individuals is extraordinarily developed.

Already differentiation among ants and termites has gone so far that the three principal functions of life, namely nutrition, reproduction and defense, are no longer found in the same individuals; "workers" are unable to reproduce or to defend the colony, males and females are unable to get food or to defend themselves, "soldiers" are unable to reproduce or even to feed themselves. At the same time co-operation within a colony is practically perfect.

It is difficult to imagine how differentiation and integration can go farther than this, and unless it does go farther progress in this direction has come to an end.

The Last Stage of Evolution

c. Intellectual evolution is the last and, from the human point of view, the most important path of progress which has ever been discovered by organisms. In lower animals intellect is either lacking or is but little developed, and behavior is guided entirely by rigid instincts; in higher animals it is more fully developed but instinct is still the rule of life; in man only has intellect become to a certain extent the master of instinct.

For thousands of years man has endeavored to improve by selective breeding certain qualities of domestic animals, and among these the intelligence of dogs and horses especially. Undoubtedly much improvement has been made but in intelligence as in other qualities a limit to improvement is sooner or later reached beyond which it is not possible to go.

There is no evidence that intellectual progress, as distinguished from diversity, is still going on among animals and that they will ultimately graduate into man's class.

* * *

In bodily complexity, social organization and intellectual capacity progressive evolution has virtually come to an end among organisms below man; further progress, if it occurs, must be in new paths and from generalized rather than highly specialized types.

Has progressive evolution come to an end in the case of man also?

II

The Successive Steps in Human Evolution

Through unnumbered millions of years evolution has moved on from the lowest form of life to the highest, from amoeba to man.

About half a million years ago the immediate progenitors of man appeared on the earth.

The earliest man-like fossil so far discovered is the Ape-man, *Pithecanthropus erectus*, of Java.

About 100,000 years ago the Neanderthal man appeared, a member of the genus *Homo* but an extinct species, *neanderthalensis*.

Then came, about 25,000 years ago, certain races of the existing species, *Homo sapiens*, such as the *Cro-Magnon* and the *Grimaldi* races.

Finally at the beginning of the historic era, say about 10,000 years ago, we find the white, yellow and black races of man, with the subdivisions of each of these, much as they are today.

1. Physical Evolution of Man

Since the beginnings of recorded history there have been very few and wholly minor evolutionary changes in the body of man. Chief among these are the decreasing size of the little toe and perhaps a corresponding increase in the size of the great toe; decreasing size and value of the wisdom teeth; and probably a general lowering of the perfection of sense organs.

These changes are in the main degenerative ones due to the less rigid elimination of physical imperfections under conditions of civilization than in a state of barbarism or savagery. Such changes are insignificant as compared with the enormous changes which led to the evolution of man from pre-human ancestors.

* * *

Individual variations due to new hereditary combinations or to environmental influences are always present but they have little or no evolutionary value.

By hybridization of various races and stocks there has come to be a complicated intermixture of racial characters, but new characters have not been evolved by hybridization; by changes in environment modifications have been produced in development but not in heredity, these are *fluctuations* and not *mutations*.

For at least 10,000 years there has been no notable progress in the evolution of the human body. The limits of physical evolution have apparently been reached in the most perfect specimens of mankind.

There is no prospect that the hand, the eye or the brain of man will ever be much more complex or perfect than at present.

By selective breeding the general level may be improved, just as it has been in domestic animals, but there are no indications that future man will be much more perfect in body than the most perfect individuals of today.

Intellectual Evolution

But if man is not growing more perfect physically surely, it will be said, he is growing more perfect intellectually. Let us examine somewhat critically this claim.

We certainly know more things than the ancients did and we are proud to think that "The minds of men are widened by the process of the suns." But it is most important to distinguish between knowledge and intellect, between things known and the capacity for knowing.

By means of language, tradition, writing the experiences of past generations can be handed on to present and future ones and thus each generation may receive the knowledge accumulated throughout the past. In this sense we are "the heirs of all the ages."

Knowledge is certainly growing, but is intellectual capacity increasing?

Does anyone think that in the past 2,000 or 3,000 years there has been any increase in human intellect comparable with the increase in knowledge? Do the best minds of today excel the minds of Socrates and Plato and Aristotle?

On the contrary it is the opinion of those who have studied the subject most that no modern race of men is the equal intellectually of the ancient Greek race.

In the two centuries between 500 and 300 B. C. the small and relatively barren country of Attica, with an area and total population about equal to that of the present State of Rhode Island, but with less than one-fifth as many free persons, produced at least 25 illustrious men.

In this small country in the space of two centuries there appeared such a galaxy of illustrious men as has never been found on the whole earth in any two centuries, perhaps not in all the centuries, since that time.

Galton concludes that the average ability of the Athenian race of that period was, on the lowest estimate, as much greater than that of the English race of the present day as the latter is above that of the African negro.

There has been no progress in the intellectual capacity of man in the past two or three thousand years, and it seems probable that the limits of intellectual evolution have been reached in the greatest minds of the race.

Increasing size of brain and complexity of nervous organization leads to mental and physical instability and disharmony, and the great increase in nervous and mental diseases in modern life warns us that there is a limit to intellectual evolution.

Even in the most distant future there may never appear greater geniuses than Socrates, Plato, Aristotle, Shakespeare, Newton, Darwin.

Undoubtedly eugenics and education can do much to raise the intellectual level of the general mass, but it cannot create a new order of intellect.

Social Evolution

But if the evolution of the human individual has come to an end certainly the evolution of human society has not. In social evolution a new path of progress has been found the end of which no one can foresee.

Evolution has progressed from one-celled organisms to many-celled, from small and simple organisms to larger and more complex ones. By the union of many individuals into a society a still larger and more complex unit of organization was formed with possibilities of almost endless progress.

Society lasts from age to age, while individuals come and go; society preserves the experiences, acquirements, wisdom of the past and hands it on to the future so that each age builds upon the preceding ones; thus society has advanced from savagery to barbarism and then to civilization and the end is not yet.

At present social evolution is proceeding at a rate which is amazing if not alarming.

All kinds of variations and mutations of the social organization are occurring and, if only we have the wisdom to preserve the good and eliminate the bad, progress will be certain and rapid.

Evolution has progressed from amoeba to man; from reflexes to instincts, intelligence and reason; from the solitary individual to the family, the tribe, the modern state, and in spite of narrow-minded politicians and reactionary senators we or our descendants will yet see the whole human race brought together into a Society of Nations.

Man's Conquest of Nature

The evolution of man is no longer limited to his body or mind nor even to society, but by adding to his own powers the forces of nature man has entered upon a new path of progress.

The differentiations of various members of a colony of ants or bees are limited to their bodies and are fixed and irreversible; but in human society differentiations are no longer confined to the bodies of individuals but have become, as it were, extra-corporeal.

By his control over nature man has taken into his evolution the whole of his environment.

Although he is not as strong as the elephant nor as deft as the spider nor as swift as the antelope nor as powerful in the

water as the whale or in the air as the eagle, yet by his control of the forces of nature outside of his body he can excel all animals in strength and delicacy of movement, in speed and power on land, in water and in air.

This new path of progress is in all respects the most important which has ever been discovered by organisms and *no one can foresee the end of this process of annexing to our own powers the illimitable forces of the universe.*

III

What of the Future?

There is no probability that a higher animal than man will ever appear on the earth.

The only reason for surmising that other species of the genus *Homo* may appear in the future is the fact that there have been species in the past which do not exist at present. These prehistoric species have everywhere been replaced by the existing species probably because they were intellectually inferior.

It is possible, of course, that similar causes may lead to the elimination of the present species but this does not seem probable for the following reasons:

(1) All races of man may and do inter-breed owing to fertility *inter se* and to the lack of geographical isolation; consequently there is a growing tendency to the breaking down of racial isolation and to the hybridization of existing races.

This is clearly shown in all countries where races, even the most distinct, have been brought together, as in North and South America, the West Indies, Australasia, Polynesia, Asia and Africa.

Such hybridization may possibly lead to the production of new types or mutants, but these would probably be "swamped" and lost unless they were isolated.

All present signs point to an intimate commingling of all existing human types within the next two or three thousand years at most.

Even if new races may be developed by psychological or social selection there is no likelihood that new species will thus arise which will supplant the existing species.

* * *

(2) The development of moral and social ideals of equal justice for all people will prevent the extermination of inferior races, and the democratic ideals of self-government and majority rule will necessarily prevent even the merciful elimination of all except the most perfect types.

The majority cannot be expected to decree its own effacement; the most that can be expected is that the majority will eliminate from reproduction only the most inferior and defective individuals. By this means the standards of the race may be preserved at the present level but they cannot be greatly advanced.

No great improvement in domesticated animals or plants would be possible if breeders were able to eliminate only the most inferior individuals, and the same will certainly be true of human breeds.



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Even if the dreams of eugenicists should come true the most that could be expected would be that the standards of the race as a whole would more nearly approach the most perfect specimens of humanity which now exist.

No Likelihood of New Species

There is little likelihood therefore that a new and higher species of man will develop on the earth.

And there is no probability that some other genus or class or phylum may give rise to an animal physically, intellectually and socially superior to man.

It is possible but not probable that the entire human species may become extinct, but even if this should happen from what other source could a superior animal arise?

No other animal approaches man in intellectual capacity, upon which depends the rational organization of society and the conquest of all nature.

However imperfect, irrational and anti-social mankind may be; however much we may at times sympathize with Mark Twain's comments on "the damned human race," we may feel confident that in the long ages of future evolution no greatly superior species will appear upon this planet.

IV

Conclusion

The human race has come up through physical, intellectual and social evolution to its present condition. In body and mind the most perfect individuals of the race have probably reached the limits of possible progress.

In the rational organization of society and in the conquest of nature no one can foresee the end.

This is now the main path of human progress, the great goal toward which the human race must continue to move for ages to come. By rational co-operation man is now able to direct and hasten his own evolution.

The powers and emotions and intellects of men are centered in the three greatest

institutions of human society, namely the State, the Church, the University.

These institutions must more and more devote themselves to the furthering of human evolution, and to us as individuals is given the opportunity of aiding in all this work of time.

What other aim is so worthy of high endeavor and great endowment? In the spirit of Ulysses let us set forth on this new path of evolution:

"Death closes all; but something ere the end,
Some work of noble note, may yet be done,

"Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die."

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